Performance comparison of AODV, DSDV and EE-DSDV routing protocol algorithm for wireless sensor network

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ABSTRACT

This paper describes a preliminary study on wireless sensor network (WSN) routing protocol algorithm with focus on energy saving strategy. Efficient energy saving and consumption will ensure the lifespan of the battery are prolonged and the delay of transmitting data will be within the acceptable range of 300 meter by 300 meter network size. The routing protocol Ad-hoc On Demand Distance Vector (AODV), Destination Sequence Distance Vector (DSDV) and Energy Efficient Destination Sequence Distance Vector (EE-DSDV) were used in the study to compare the performance of the network in terms of maximum delay, throughput receive as well as the remaining energy in the network.

Keywords
Wireless sensor network, Energy aware, Throughput, Delay

1.0 INTRODUCTION

Convergence of wireless communications, smart sensors and embedded system enables us to have greater advancement in wireless sensor network. The vision for this technology is to improve the capability to monitor, capture, and analyze events in operation and environment so that faster identification and response can be taken to improve the overall performance. Sensor nodes also have the capabilities to communicate bidirectional with other sensors using multi-hop approach by forwarding each other's message and thus network connectivity area can be expanded.

Wireless sensor network has a variety of applications such as environmental monitoring, military surveillance and seismic detection. Routing algorithm is now a research focus as one of the ways to overcome these challenges. Each of the routing algorithms in wireless sensor network has different characteristics compared to the routing algorithm in conventional communication network. Thus data transmitted through WSN nodes need to improve such that an efficient energy saving routing technique can be achieved through several strategies such as minimum energy path, maximum residual energy path, cluster-based routing or path with minimum number of hops to sink. The work propose in this paper is to compare the energy performance of commonly used routing algorithm in WSN is AODV, DSDV with an Energy Efficient DSDV (EE-DSDV).

2.0 REVIEW OF AODV, DSDV AND EE-DSDV.

2.1 DSDV

Destination-Sequenced Distance Vector (DSDV) protocol is transmitted between the stations of the network by using routing table which are stored as each station of the network. Each routing table, at each of the station, lists all the available destination and number of hops [1]. To maintain the consistency of routing tables in a dynamically varying topology, each station periodically transmits updates. Update data is transmitted immediately when significant new information is available, this result to more power will be consumed and the lifespan of the batteries will be shortened.

2.2 AODV

The Ad hoc on-demand Distance Vector (AODV) algorithm enables dynamic, self-starting, multi hop routing between participating mobile nodes wishing to establish and maintain ad hoc network. The operation of AODV is loop-free and offers quick convergence by avoiding the Bellman-Ford "counting to infinity" problem when the ad hoc network topology changes. [2] One distinguishing feature of AODV is the destination sequence number table for each route entry. The destination sequence number is created by the destination to be included along with any route information it sends to requesting nodes. This will cause some delay in network but less of power consumption.

2.3 EE-DSDV

The energy efficient routing protocol algorithm was introduced to address the problem face by DSDV and AODV. Energy Efficient DSDV routing protocol algorithm used DSDV as the host. At the network layer the enhancements introduce in EE-DSDV are expected to provide longer lifetime of nodes with low residual battery power. The EE-DSDV would force “to sleep” the hot spot nodes for consuming more energy for forwarding data packet. The monitoring technique need in estimating the lifetime of hot spot node is as follow:-

$$\lambda = \frac{RPBi}{FPB} \quad (1)$$

Where:
RPB = Residual Battery Power
FPB = Full Battery Power
i = The hot spot node

When the energy of any intermediate nodes were reduce below threshold value, it would immediately change to sleep mode where it would not be able forward any packet except transmit it own data. The source node will find other route to reach the destination nodes. [3] When all intermediate nodes have reached its threshold value of 70%, the algorithm would automatically adjust the threshold to a new level of 35% of residual battery power. This would turn on the intermediate nodes to live again to start forwarding packet until it reach the second threshold value. Figure 1 shows flow chart of the EE-DSDV algorithm:

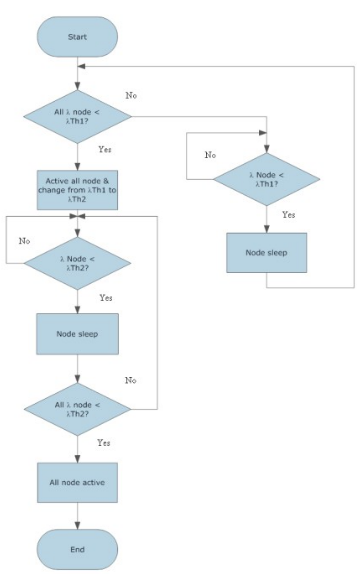

Figure 1: EE-DSDV Flowchart process

3.0 SIMULATION TOOLS

Network Simulator 2 (NS-2) was used as a simulation tool to simulate the scenario as in the real network environment such that the simulation results were expected to mirror the real network behavior [4]. NS-2 can be used as:

- A design tool for developing a new system.
- An analysis tool for making changes in existing system.

NS-2 version 2.29, which support Mannasim, is a variant of REAL network simulator developed by UC Berkeley in 1989 [4]. The software work on any Linux based operating system, for this work Ubuntu and Xandros were used.

The trace file produced by NS-2 was then analyzed using Tracegraph analyzer and .awk script to obtained the measured parameter that is maximum delay, throughput received and must important that the energy consumption of the network.

4.0 SIMULATION ENVIRONMENT

NS-2 with add-ons Mannasim can produce WSN environment for simulation work. The WSN topology was design in such way that the 9 static nodes was distributed evenly in an area 300m by 300m as shown in Figure 2.

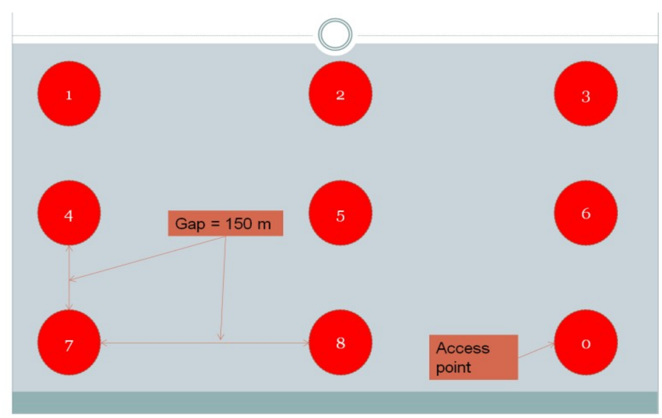

Figure 2: EE-DSDV Flowchart process

The distant between each neighbor is 150 meter. The simulation scenario, all nodes are communicating and each node needs to send data to the access point or sink node. In this case, Node 0 is set to be the sink node as shown in Figure 2. The simulation starts at 0.1 second and each simulation run for 4500 seconds. At the beginning of the simulation, each common node is equipped with 10J of energy meanwhile the access point node is equipped with

250J of energy. The initial energy to the access point is set to high since it is receiving data packets from all the neighboring nodes and consumes much more energy compare to other node. The source node sends UDP data packets at a rate of 5 packets / sec. and the packet size is set to be 500 bytes. The physical data rate is set to 20 Kbps. The physical layer parameters are selected based on IEEE 802.11. A two-ray path loss model is used as radio propagation model. The transmission power is set to be 0.024 W and reception power is set to be 0.036 W [5].

5.0 SIMULATION RESULT

The study comparing performance of the network in term of maximum delay, throughput receive as well as the remaining energy in the network, using AODV, DSDV and EE-DSDV performance.

First parameter being compared is the maximum delay from source node for three routing protocol as shown in Figure 3.

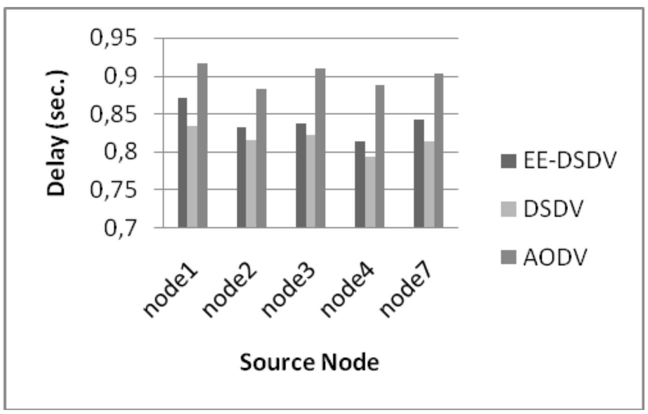

Figure 3: Maximum delay with difference routing protocol

From the graph, EE-DSDV and DSDV perform much better compared to AODV in term of maximum delay. This is because the AODV always works based on-demand request packet to transferring any data. EE-DSDV and DSDV are always in "active mode" which requires some packet to be sent between the nodes all time for updating status.

Results for the throughput receive are shown in Figure 4. From the graph, the throughput receives for AODV considerably higher than DSDV and EE-DSDV. This is because AODV did not have additional updating packet as DSDV and EE-DSDV. Thus AODV would fully utilize the packet allocation allocated to it to transfer data packet as compared to DSDV and EE-DSDV. However, AODV experience a reduction in packet transfer from 305 to 250 when the simulation time is over 2500 second and eventually there was no packet being transferred by the network that utilized AODV after 3000 second.

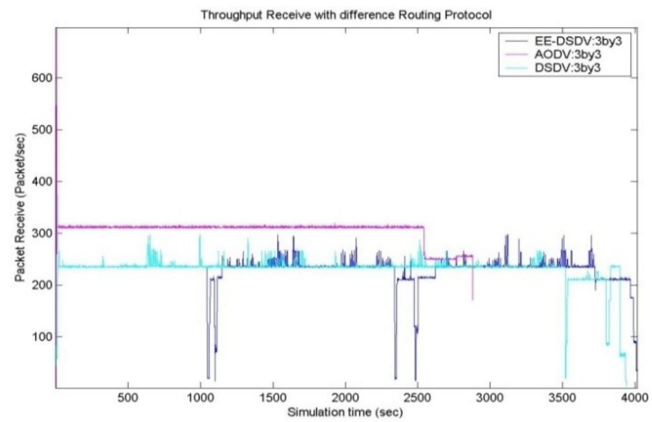

Figure 4: Throughput receive versus time with difference routing protocol

From the graph, it can also be seen that intermediate node of EE-DSDV received a small amount of packet when it was forced to sleep mode. This happen when the energy reached the first and second threshold level that is at 70% and 35% at time equal to 1000 and 2500 second respectively.

The action taken to force to sleep mode of the intermediate nodes that have reached the threshold level have forced the packet to re-route to another intermediated node and queue happen at each these nodes (that does not reached the threshold level). During the transition the period the buffer at these nodes will be filled up at faster rate thus packets are force to drop during the transmission.

Finally the .awk script was used to analyze the energy utilization at every node within the area. The energy consumption at intermediate node of 5, 6 and 8 are shown in Figure 5, 6 and 7 respectively.

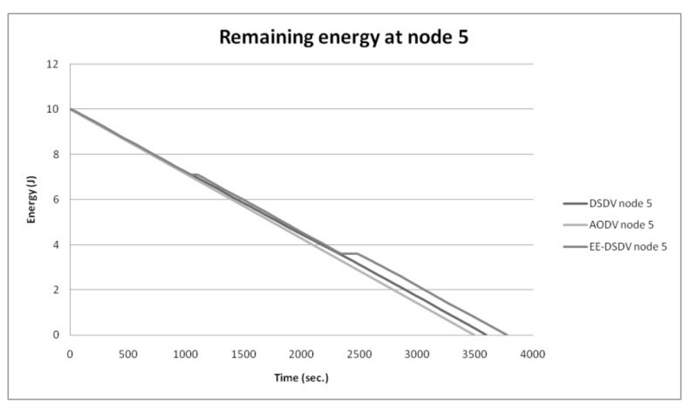

Figure 5: Energy versus time at node 5 with difference routing protocol

The life time of the batteries in EE-DSDV for all intermediate nodes exceed the other routing protocol by about 5%. This is because EE-DSDV works with energy strategy that will force this node to sleep mode when it's remaining energy reach threshold value at 70 % and 35 % of full energy power. Energy-aware based on DSDV routing protocol can be prolong it life time by applying this energy saving strategy. The same result happen to two others intermediate node as per Figure 6 for node 6 and Figure 7 for node 8.

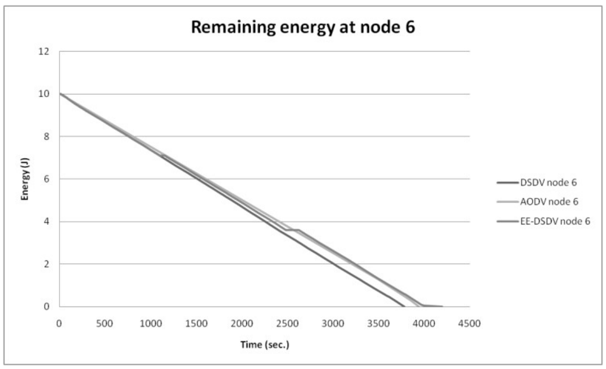

Figure 6: Energy versus time at node 6 with difference routing protocol

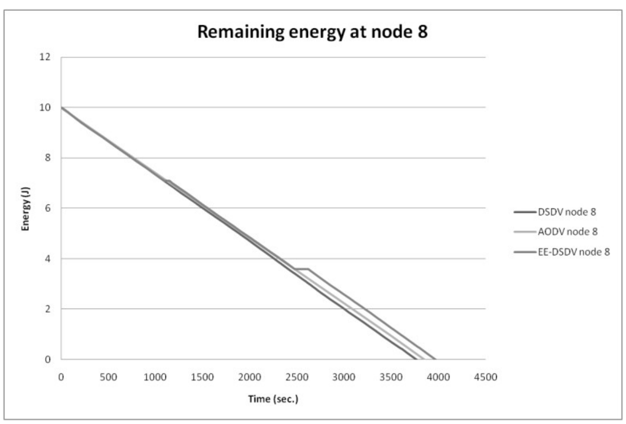

Figure 7: Energy versus time at node 8 with difference routing protocol

The strategy used in EE-DSDV algorithm to force node to sleep when reach 70% and 35% of full energy can see by clock sleep time as Table 1.

Table 1: *Time node start to sleep.*

	Sleep time (sec.)		
Threshold value	Node 5	Node 6	Node 8
70%	1099	1099	1049
35%	2518	2650	2650

The improvement in the energy saving of about 181 sec at intermediated node 5 can be seen when the network utilized EE-DSDV when compare to DSDV. Table 2 show overall energy saving produced by EE-DSDV compared with AODV and DSDV.

Table 2: *Improvement EE-DSDV to other routing protocol.*

Node	Death node clocked (sec.)			Improvement	
	EE-DSDV	DSDV	AODV	Sec.	%
Node 5	3774	3593	3488	181	5.04
Node 6	4198	3782	3941	257	6.52
Node 8	3968	3769	3853	115	2.98

The result shows that the strategy used in designing the EE-DSDV algorithm such as minimum energy path, cluster based routing with minimum number of hop to sink, works in prolong the life-span of the battery as compare with AODV and DSDV.

6.0 CONCLUSION

This paper has successful shows that with a good energy strategy algorithm, such as EE-DSDV, the lifespan of the intermediate node would be extended. The EE-DSDV algorithm effectively prolongs the lifespan of the intermediate node 5, 6 and 8 by about 181, 257 and 115 seconds respectively. The delay in transmitting packet was also reduce by about 0.07 second when compare with AODV.

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